Cheat Sheet: Biopsychology

Essential Concepts

The Nervous System

- The central nervous system is comprised of the brain and spinal cord. The peripheral nervous system is comprised of the somatic and autonomic nervous systems.
- Neurons and glia are the two cell types that make up the nervous system. While glia generally play supporting roles, the communication between neurons is fundamental to all of the functions associated with the nervous system.
- Neuronal communication is made possible by the neuron's specialized structures. The soma contains the cell nucleus, and the dendrites extend from the soma in tree-like branches. The axon is another major extension of the cell body; axons are often covered by a myelin sheath, which increases the speed of transmission of neural impulses. At the end of the axon are terminal buttons that contain synaptic vesicles filled with neurotransmitters.
- Neuronal communication is an electrochemical event. The dendrites contain receptors for neurotransmitters released by nearby neurons. If the signals received from other neurons are sufficiently strong, an action potential will travel down the length of the axon to the terminal buttons, resulting in the release of neurotransmitters into the synaptic cleft. Action potentials operate on the all-or-none principle and involve the movement of Na+ and K+ across the neuronal membrane.
- Different neurotransmitters are associated with different functions. Often, psychological disorders involve imbalances in a given neurotransmitter system. Therefore, psychotropic drugs are prescribed in an attempt to bring the neurotransmitters back into balance. Drugs can act either as agonists or as antagonists for a given neurotransmitter system.

The Brain

- The brain consists of two hemispheres, each controlling the opposite side of the body. Each hemisphere can be subdivided into different lobes: frontal, parietal, temporal, and occipital.
- In addition to the lobes of the cerebral cortex, the forebrain includes the thalamus (sensory relay) and limbic system (emotion and memory circuit).

- The midbrain contains the reticular formation, which is important for sleep and arousal, as well as the substantia nigra and ventral tegmental area. These structures are important for movement, reward, and addictive processes.
- The hindbrain contains the structures of the brainstem (medulla, pons, and midbrain), which control automatic functions like breathing and blood pressure. The hindbrain also contains the cerebellum, which helps coordinate movement and certain types of memories.

Studying the Brain

- Individuals with brain damage have been studied extensively to provide information about the role of different areas of the brain. The rare split-brain patients offer helpful insights into how the brain works.
- Recent advances in technology allow us to glean similar information by imaging brain structure and function. These techniques include CT, PET, MRI, fMRI, EEG, DOI, TMS, and tDCS.

The Peripheral Nervous System and the Endocrine System

- The peripheral nervous system is comprised of the somatic and autonomic nervous systems.
    - The somatic nervous system transmits sensory and motor signals to and from the central nervous system.
    - The autonomic nervous system controls the function of our organs and glands, and can be divided into the sympathetic and parasympathetic divisions.
        - Sympathetic activation prepares us for fight or flight, while parasympathetic activation is associated with normal functioning under relaxed conditions.
- The endocrine system consists of a series of glands that produce chemical substances known as hormones, which produce widespread effects on the body and regulate normal body functions.
    - The hypothalamus serves as the interface between the nervous system and the endocrine system, and it controls the secretions of the pituitary.
    - The pituitary serves as the master gland, controlling the secretions of all other glands.
    - The thyroid secretes thyroxine, which is important for basic metabolic processes and growth; the adrenal glands secrete hormones involved in the stress

response; the pancreas secretes hormones that regulate blood sugar levels; and the ovaries and testes produce sex hormones that regulate sexual motivation and behavior.

Behavior and Genetics

- The nature-nurture debate revolves around the question of whether an individual's traits and behaviors are primarily determined by genetics or by environmental factors, and it has been a contentious issue in psychology. However, most human characteristics do not have a straightforward nature or nurture explanation.
- Genes are sequences of DNA that code for a particular trait. Different versions of a gene are called alleles—sometimes alleles can be classified as dominant or recessive. A dominant allele always results in the dominant phenotype. In order to exhibit a recessive phenotype, an individual must be homozygous for the recessive allele. Genes affect both physical and psychological characteristics.
- Ultimately, how and when a gene is expressed, and what the outcome will be—in terms of both physical and psychological characteristics—is a function of the interaction between our genes and our environments. This perspective challenges the notion of a fixed or limited genotype.

Glossary

action potential

an electrical signal that moves down the neuron's axon

adoption study

a behavior genetic research method that involves comparison of adopted children to their adoptive and biological parents

adrenal gland

sits atop our kidneys and secretes hormones involved in the stress response

agonist

a drug that mimics or strengthens the effects of a neurotransmitter

allele

a specific version of a gene

amygdala

structure in the limbic system involved in our experience of emotion and tying emotional meaning to our memories

antagonist

a drug that blocks or impedes the normal activity of a given neurotransmitter

auditory cortex

a strip of cortex in the temporal lobe that is responsible for processing auditory information

autonomic nervous system

controls our internal organs and glands

axon

a major extension from the neuron's soma, which allows electrical signals to be passed from one neuron to another

axon terminals (terminal buttons)

the ends of a neuron's axon where synaptic vesicles containing neurotransmitters send chemical messages to the next neuron

behavioral endocrinology

the study of psychology and the endocrine system; the scientific study of the interaction between hormones and behavior

behavioral genetics

the empirical science of how genes and environments combine to generate behavior

biological perspective

the view that psychological disorders like depression and schizophrenia are associated with imbalances in one or more neurotransmitter systems

brain

a complex organ comprised of billions of interconnected neurons and glia, it provides the foundation for our thoughts and behaviors

Broca's area

a region in the left hemisphere that is essential for language production

central nervous system (CNS)

the brain and spinal cord

cerebellum

hindbrain structure that controls our balance, coordination, movement, and motor skills, and it is thought to be important in processing some types of memory

cerebral cortex

the surface of the brain that is associated with our highest mental capabilities

chromosome

a long strand of genetic information

coma

a deep state of prolonged unconsciousness in which a person cannot be awakened, fails to respond normally to painful stimuli, light, or sound, lacks a normal wake-sleep cycle and does not initiate voluntary actions

computerized tomography (CT) scan

imaging technique in which a computer coordinates and integrates multiple x-rays of a given area

contralateral

relating to the opposite side of the body; in the brain, this refers to how the left hemisphere controls activity on the right side of the body, and vice versa

corpus callosum

a thick band of neural fibers connecting the brain's two hemispheres

dendrites

branch-like extension of the soma that receives incoming signals from other neurons

deoxyribonucleic acid (DNA)

a double helix-shaped molecule made of nucleotide base pairs

depolarization

when a cell's charge becomes positive, or less negative

diabetes

disease related to insufficient insulin production

dominant allele

allele whose phenotype will be expressed in an individual that possesses that allele

electroencephalography (EEG)

recording the electrical activity of the brain via electrodes on the scalp

endocrine system

series of glands that produce chemical substances known as hormones

epigenome

a dynamic layer of information associated with DNA that differs between individuals and can be altered through various experiences and environments

epigenetics

study of gene-environment interactions, such as how the same genotype leads to different phenotypes

fight or flight response

activation of the sympathetic division of the autonomic nervous system, allowing access to energy reserves and heightened sensory capacity so that we might fight off a given threat or run away to safety

forebrain

the largest part of the brain, containing the cerebral cortex, the thalamus, and the limbic system, among other structures

fraternal twins

twins who develop from two different eggs fertilized by different sperm, so their genetic material varies the same as in non-twin siblings

frontal lobe

the part of the cerebral cortex involved in reasoning, motor control, emotion, and language; contains motor cortex

functional magnetic resonance imaging (fMRI)

MRI that shows changes in metabolic activity over time

gene

a sequence of DNA that controls or partially controls physical characteristics

genetic environmental correlation

view of gene-environment interaction that asserts our genes affect our environment, and our environment influences the expression of our genes

genotype

the genetic makeup of an individual

glial cell

a nervous system cell that provides physical and metabolic support to neurons, including neuronal insulation and communication, and nutrient and waste transport

gonad

secretes sexual hormones, which are important for successful reproduction, and mediate both sexual motivation and behavior

gyrus (plural: gyri)

a bump or ridge on the cerebral cortex

heritability

the proportion of difference among people that is attributed to genetics

heritability coefficient

a number that is meant to provide a single measure of genetics' influence on a trait (the number is between 0 to 1, with 1 being the strongest genetic influence); measures how strongly differences among individuals are related to differences among their genes

heterozygous

consisting of two different alleles

hindbrain

division of the brain containing the medulla, pons, and cerebellum

hippocampus

structure in the temporal lobe associated with learning and memory

homeostasis

state of equilibrium—biological conditions, such as body temperature, are maintained at optimal levels

homozygous

consisting of two identical alleles

hormone

chemical messenger released by endocrine glands

hypothalamus

forebrain structure that regulates sexual motivation and behavior and a number of homeostatic processes; serves as an interface between the nervous system and the endocrine system

identical twins

twins that develop from the same sperm and egg

lateralization

the concept that each hemisphere of the brain is associated with specialized functions

limbic system

the collection of structures involved in processing emotion and memory

longitudinal fissure

a deep groove in the brain's cortex

magnetic resonance imaging (MRI)

magnetic fields used to produce a picture of the tissue being imaged

medulla

hindbrain structure that controls automated processes like breathing, blood pressure, and heart rate

membrane potential

a difference in charge across the neuronal membrane

midbrain

division of the brain located between the forebrain and the hindbrain; contains the reticular formation

motor cortex

a strip of the cortex involved in planning and coordinating movement

mutation

sudden, permanent change in a gene

myelin sheath

a fatty substance that insulates axons which increases the speed at which the signal travels

neuron

cells in the nervous system that act as interconnected information processors, which are essential for all of the tasks of the nervous system; the central building blocks of the nervous system

neuroplasticity

the ability of the nervous system to change and adapt

neurotransmitters

small molecules that are the chemical messengers of the nervous system

nervous system

the body's communication network that consists of all nerve cells, is divided into two major subdivisions: the central nervous system and the peripheral nervous system

nodes of Ranvier

small gaps that occur in the myelin sheath down the length of the axon

occipital lobe

part of the cerebral cortex associated with visual processing; contains the primary visual cortex

pancreas

secretes hormones that regulate blood sugar

parasympathetic nervous system

associated with routine, day-to-day operations of the body

parietal lobe

part of the cerebral cortex involved in processing various sensory and perceptual information; contains the primary somatosensory cortex

peripheral nervous system (PNS)

connects the brain and spinal cord to the muscles, organs, and senses in the periphery of the body

pituitary gland

secretes a number of key hormones, which regulate fluid levels in the body, and a number of messenger hormones, which direct the activity of other glands in the endocrine system

phenotype

individual's inheritable physical characteristics

polygenic

multiple genes affecting a given trait

pons

hindbrain structure that connects the brain and spinal cord; involved in regulating brain activity during sleep

positron emission tomography (PET) scan

involves injecting individuals with a mildly radioactive substance and monitoring changes in blood flow to different regions of the brain

prefrontal cortex

area in the frontal lobe responsible for higher-level cognitive functioning

psychotropic medication

drugs that treat psychiatric symptoms by restoring neurotransmitter balance

quantitative genetics

scientific and mathematical methods for inferring genetic and environmental processes based on the degree of genetic and environmental similarity among organisms

range of reaction

asserts our genes set the boundaries within which we can operate, and our environment interacts with the genes to determine where in that range we will fall

receptors

proteins on the cell surface where neurotransmitters attach—they vary in shape, with different shapes "matching" different neurotransmitters

recessive allele

allele whose phenotype will be expressed only if an individual is homozygous for that allele

resting potential

the state of readiness of a neuron membrane's potential between signals

reticular formation

midbrain structure important in regulating the sleep/wake cycle, arousal, alertness, and motor activity

reuptake

when neurotransmitters in the synaptic cleft drift away or are broken down into inactive fragments, or reabsorbed back into the neuron following action potential

spinal cord

connects the brain to the outside world; a relay station that routes messages to and from the brain and is responsible for reflexes

semipermeable membrane

cell membrane that allows smaller molecules or molecules without an electrical charge to pass through it, while stopping larger or highly charged molecules

soma

the cell body of a neuron

somatic nervous system

relays sensory and motor information to and from the CNS

somatosensory cortex

essential for processing sensory information from across the body, such as touch, temperature, and pain

sulcus (plural: sulci)

depressions or grooves in the cerebral cortex

sympathetic nervous system

involved in stress-related activities and functions

synaptic vesicles

small, membrane bound sacs at housed at axon terminals in neurons, which hold and transport neurotransmitters; storage site for neurotransmitters

synaptic cleft (synapse)

small gap between two neurons where communication occurs

temporal lobe

part of the cerebral cortex associated with hearing, memory, emotion, and some aspects of language; contains primary auditory cortex

thalamus

sensory relay station for the brain

theory of evolution by natural selection

states that organisms that are better suited for their environments will survive and reproduce compared to those that are poorly suited for their environments

threshold of excitation

level of charge in the membrane that causes the neuron to become active

thyroid gland

secretes hormones that regulate growth, metabolism, and appetite

twin studies

a behavior genetic research method that involves comparison of the similarity of identical (monozygotic; MZ) and fraternal (dizygotic; DZ) twins

ventral tegmental area (VTA)

midbrain structure where dopamine is produced: associated with mood, reward, and addiction

Wernicke's area

part of the brain that is important for speech comprehension